REMARKS

Claims 17, 18, 21, 24 and 31 have been canceled, and new claims 32-34 have been added. No new matter was added. Thus, claims 1, 6, 28 and 32-34 are pending. Arguments are submitted for overcoming the rejections based on the prior art of record. Accordingly, Applicants respectfully submit that the present application is in condition for allowance.

I. Claim Rejections - 35 USC §102(b)

> *In the non-final Office Action dated September 3, 2008, claims 1, 17, 18 and 21 are rejected under 35 USC §102(b) as being anticipated by newly cited U.S. Patent No. 6,165,874 issued to Powell et al.*

Claims 17, 18 and 21 are canceled. Independent claim 1 has been amended to recite the subject matter formerly stated in claims 17, 18 and 21. No new matter was added.

Applicants respectfully submit that independent claim 1 is patentable and is not anticipated by the newly cited Powell et al. reference.

As a matter of basic U.S. patent law, a claim of a patent application is anticipated under 35 USC §102 only if each and every element is found described in a single prior art reference. The identical invention must be shown in as complete detail as contained in the claim. The elements identified by the reference must be arranged as required by the claim. If a prior art reference relied on in a rejection made under 35 USC §102 does not contain every element recited in the claim in as complete detail as is contained in the claim and arranged as recited in the claim, the rejection is improper and should be removed.

Applicants respectfully submit that Powell et al. fail to disclose the "identical invention" and "each and every element" arranged as required by claim 1. For this reason, Applicants respectfully request removal of the §102 rejection.

Independent claim 1 requires a silicon carbide epitaxial wafer formed on a 4H-SiC substrate. The epitaxial wafer is formed on the {0001} C face of the substrate at less than a 1° angle. The wafer is required to have a flat surface, and a semiconductor device is required to be formed on the wafer.

New dependent claim 34 requires the wafer to be of the same 4H-SiC crystal structure as the substrate. No new matter was added. For example, see page 1, lines 14-16, of the present application, as filed, which states that "SiC has various crystal structures" and that "SiC having a **different crystal structure** easily gets mixed into the epitaxially grown portion." Also, see reference to U.S. Patent No. 4,912,064 on page 1, lines 17-24, of the present application, as filed. The '064 patent relates to forming a silicon carbide film on a silicon carbide substrate "of the same polytype". Further, see page 2, lines 9-12, of the present application with respect to the stated objective of reducing "crystal defects" (i.e. different crystal structures other than that of the substrate) in the SiC wafer portion. Also, see FIGs. 1a and 1b of the present application, as filed, which each show an "epitaxial layer" of the same structure as the "substrate" (i.e. homoepitaxial growth of 4H-SiC on a 4H-SiC substrate).

Turning to the newly cited Powell et al. patent, it provides a teaching with respect to growing a 3C-SiC layer on a 6H-SiC substrate. For example, see column 9, lines 1-6, of Powell et al. which summarizes the objectives of Powell et al., as follows:

> "As discussed above, 3C-SiC, to our knowledge, is not available in high-quality single-crystal wafer form; hence, the epitaxial 3C-SiC device structures must be grown heteroepitaxially on some other material. The present invention overcomes the problem of prior art in the growth of high-quality low-defect 3C-SiC films on 6H-SiC substrates."

By way of simple background discussion, column 6, line 59, to column 7, line 25, of Powell et al. provides a description with respect to different silicon carbide crystal structures

including 3C, 4H and 6H. However, Powell et al. clearly focus their disclosure with respect to forming 3C-SiC films. For example, see column 7, lines 51-54, which states:

> "As of now, to our knowledge, there is no existing method for producing large (greater than 1-inch diameter) high-quality single-crystal 3C-SiC boules. Hence, no acceptable quality 3C-SiC wafers are available."

Under the "Summary of the Invention" section of Powell et al., the disclosed invention is clearly directed to "a method of growing high-quality low-defect polytypic compounds **heteroepitaxially** on polytypic compound substrates that are **different than the film**." (See column 11, lines 25-30, of the Powell et al. reference.) The examples provided by Powell et al. are limited to the growth of 3C-SiC, 2H-AlN, and 2H-GaN on 6H-SiC substrates. For example, see column 11, lines 28-30. Also, see column 12, lines 50-53, which states:

> "Thus, the present invention can be applied to the growth of usefully large device-sized regions of low-defect films of 3C-SiC, 2H-AlN, and 2H-GaN on 6H-SiC substrates."

The only exception is that on column 12, lines 29-30, Powell et al. disclose that "Other SiC polytypes, such as 4H-SiC could also be used as substrates". However, Powell et al. clearly teach that the use of 4H-SiC substrates is limited to the growth of 2H-AlN and 2H-GaN. For example, on column 13, lines 9-13, Powell et al. teach that "**only** a single orientation of the 3C polytype will form on an atomically-flat 6H sequence under suitable growth conditions" and that "it is expected that the same behavior will hold for the 2H sequence grown on the 4H or 6H sequence." Thus, Powell et al. teach that a 4H-SiC substrate can only be used in connection with the heteroepitaxial growth of 2H-AlN and 2H-GaN, not 3C-SiC.

In contrast to the teachings and disclosure of Powell et al., the present invention is limited to the homoepitaxial growth of silicon carbide on a silicon carbide substrate having a 4H crystal structure. The teachings of Powell et al. are clearly limited to heteroepitaxial growth of 3C-SiC

on 6H-SiC or to heteroepitaxial growth of 2H-AlN or 2H-GaN on 6H-SiC or 4H-SiC. The technology and disclosure of Powell et al. are clearly different than that of claims 1 and 34 of the present application. For the above reasons, Powell et al. fail to disclose each and every limitation of claims 1 and 34 and fail to arrange each and every limitation as required by claims 1 and 34 of the present application. For at least these reasons, Applicants respectfully request reconsideration and removal of the above referenced §102 rejection.

An additional reason for patentability of claims 1 and 34 over Powell et al. is that Powell et al. provide the following teaching on column 16, lines 35-39:

> "Si-face 50 is polished and used for epitaxial growth. It has been found that Si-face 50 produces the highest-quality epitaxial layer films which have the best surface morphology and lowest defects."

Claim 1 of the present application requires epitaxial growth of the wafer on the C face of the substrate. Thus, Powell et al. fail to provide such a teaching and, in fact" teach away" from growth on any face other than the Si-face because, as one of skill in the art is clearly taught by Powell et al., the Si-face "produces the highest-quality epitaxial layer films which have the best surface morphology and lowest defects". Thus, reconsideration and removal of the above referenced rejection are requested for this additional reason.

Still further, the teachings of Powell et al. with respect to tilt angles of less than 1° are limited to heteroepitaxial growth of 3C-SiC on a 6H-SiC substrate. For example, see: column 7, lines 62-65 and column 8, lines 26-33. Powell et al. clearly fail to teach, suggest or disclose the "less than 1°" limitation required by claim 1 of the present application with respect to a 4H-SiC substrate and homoepitaxial grown wafer. Without such an express teaching by Powell et al., the anticipation rejection should be found improper and should be removed.

For all the reasons discussed above, claims 1 and 34 recite subject matter that is different and novel relative to the disclosure of the Powell et al. patent. Applicants respectfully request reconsideration and removal of the §102 rejection for these reasons.

II. Claim Rejections - 35 USC §103(a)

> *In the non-final Office Action dated September 3, 2008, claims 6, 24, 28 and 31 are rejected under 35 USC §103(a) as being obvious over U.S. Patent No. 6,165,874 issued to Powell et al. in view of the IEEE publication of Steckl et al.*

Claims 24 and 31 are canceled. Independent claim 6 has been amended to recite the subject matter formerly stated in claim 34, and independent claim 28 has been amended to recite the subject matter formerly stated in claim 31. No new matter was added.

Applicants respectfully submit that independent claims 6 and 28 are patentable and are not obvious relative to the newly cited Powell et al. reference in view of the newly cited Steckl et al. publication. New dependent claims 32 and 33 are similar to new claim 34, discussed above. Accordingly, Applicants respectfully submit that no new matter was added.

As discussed above in detail, the disclosure of Powell et al. relates to **heteroepitaxial growth** of 3C-SiC on a 6H-SiC substrate. In fact, Powell et al. "teach-away" from homoepitaxial growth stating that a disadvantage of such growth is that it requires "**growth on 'offaxis'** commercial wafer". See column 10, lines 1-9, of the Powell et al. patent. Further, Powell et al. "teach-away" from growth on the C face of the substrate and teach to one of ordinary skill in the art that the Si-face "produces the highest-quality epitaxial layer films which have the best surface morphology and lowest defects". See column 16, lines 35-39, of the Powell et al. patent.

In addition, in the Office Action, it is readily acknowledged that Powell et al. fail to teach claim limitations requiring "cleansing a surface of a substrate with a mixed gas of hydrogen gas and propane gas at 1400°C to 1600°C" and "a growth pressure of 250mbar or less". The Steckl et al. publication is cited for this purpose. However, Applicants respectfully submit that the disclosure provided by Steckl et al. has been misinterpreted and misapplied.

Steckl et al. use a mixed gas of hydrogen and propane to transform a Si wafer surface into SiC. This technique is referred to as "carbonization". If propane gas is supplied to the Si wafer surface at a temperature of about 1300°C, which is close to the melting temperature of Si, a chemical reaction will occur between the Si wafer and the propane gas, and an ultra-thin film layer of polycrystalline SiC is thereby formed on the Si wafer surface. This is the teaching provided by the Steckl et al. publication to one of ordinary skill in the art, and this teaching is completely different from etching technology (surface cleansing technology) required by the claims of the present application.

The present invention cleanses/etches the silicon carbide substrate surface at a temperature of 1400°C to 1600°C; however, a chemical reaction between Si and the propane gas does not occur since the substrate required by the claims of the present application is SiC, not Si (as required by Steckl et al.). Since the cleansing required by the present invention is at a high temperature (1400°C to 1600°C), a chemical reaction between hydrogen and SiC becomes noticeable, and, as a result of this reaction, SiC decomposes and the surface of the SiC substrate is chemically polished (i.e. etched). This makes it possible to remove the damaged layer of the surface to reveal a step of 1nm or less.

The method steps and technology disclosed by Steckl et al. are unable to achieve the etching results of the present invention. Furthermore, Powell et al. uses a mixed gas of hydrogen

chloride and hydrogen gas to cleanse the wafer surface (see column 17, lines 12-15, of Powell et al.), and this is also clearly different than the present invention.

Accordingly, Applicants respectfully submit that one of ordinary skill in the art does not arrive at the present invention as required by claims 6 and 28 of the present application merely by combining the teachings of Powell et al. with that of the Steckl et al. publication.

With respect to claim 6, as amended, it now requires the substrate to have a surface step of 1nm or less. Applicants respectfully disagree that column 20, lines 59-65, of Powell et al. discloses such a limitation. This passage of Powell et al. merely indicates that there is heteroepitaxial growth of 3C-SiC on a 6H-SiC substrate (referred to as "the c-axis repeat distance of 3C-SiC" in the text of Powell et al.). This disclosure is totally unrelated to the homoepitaxial growth of the present invention. The object of the present invention is to inhibit the growth of 3C-SiC, that is, to inhibit the generation of other forms, and it would be clearly erroneous to consider the present invention and Powell et al. to disclose the same subject matter or subject matter that is a mere obvious variation.

Still further, claims 6 and 28 of the present application require the use of source gases having "a compositional ratio of C and Si of 1 or less" during the growing step (i.e. $C/Si \leq 1$ or $Si/C \geq 1$). In contrast, Powell et al. teach that the ratio of Si to C is within a range of 0.1 to 0.8 (see column 17, lines 49-52) or is 0.44 (see column 20, lines 13-17). Thus, Powell et al. teach that: $0.1 \leq Si/C \leq 0.8$. Accordingly, it is clear that the conditions of growth required by Powell et al. require Si content of a lower atomic ratio than C content. However, in direct contrast, the present invention requires Si content to have an equal or higher atomic ratio than the C content. Thus, it is clear that Powell et al. teach different epitaxial growth conditions relative to the present invention. One of ordinary skill in the art following the teachings of Powell et al. would

utilize a compositional ratio that does not overlap the compositional ratio required by claims 6 and 28 of the present application.

Accordingly, for all the reasons stated above, Applicants respectfully submit that one of ordinary skill in the art would not arrive at the present invention or find the invention obvious based merely on the combination of teachings of Powell et al. and the Steckl et al. publication. Applicants respectfully request reconsideration and removal of the obviousness rejection.

III. Conclusion

In view of the above amendments and remarks, Applicants respectfully submit that the claim rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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